P CHARACTERIZATION IN ACID PASTURE SOILS AND ITS RELATION WITH PLANT ROOT SYSTEMS AND MINERAL COMPOSITION

J Pastor and A Urcelay, Biología Ambiental, CSIC, Madrid
AJ Hernández, Ecología, Universidad de Alcalá de Henares, Madrid

Processes are very complex in the natural environment, so the effects of acidity on P soil dynamics cannot be considered in isolation. This paper attempts to show the different forms which this element can take in the soil; some insoluble phosphates can be slowly liberated into the soil labile P pool, and must also be considered a source of "available" P in acid media. Root length per soil volume (or root density) is also noted since root weight is not the best criterion when considering possible sources for plant mineral nutrition.

Material & Methods: Sixteen pastures with distric cambysol soil at pH 5-6 whose mediterranean geo-edaphic and root characteristics have been described in earlier papers are studied here (Hernández et al 1988, Pastor et al 1989). Available soil P was analyzed with the Bray 1 method and the other fractions were analyzed following the Chang et al technique. Both techniques, together with those used to analyze P in the aerial portion of the plants as well as root density are described in Hernández et al 1989.

Results & Discussion: The contents of the different P fractions are shown in Table 1. Analysis of this element in the most abundant species in these pastures (Table 2) has shown a significant positive relation between this nutrient and available P, particularly in Agrostis castellana, Bromus hordaceus, Trifolium subterraneum, T. cernuum and Ornithopus compressus. At the same time, these phosphates positively correlate with the large grained sand fraction.

Sites	Sand %	Al meq	Phosphates (ppm) P-Asim	P-Sol	P-Al	P-Fe	P-Ca	Lv cm cm -3
1	64,7	0,22	40	0	49	44	80	3,08
2	41,9	0	14	0	44	100	25	13,14
3	59,8	0,24	94	0	130	165	75	10,79
4	73,9	1,18	113	0	149	135	35	9,90
5	91,9	0,44	67	0	104	90	405	20,20
6	40,9	0,82	13	0	46	100	20	35,42
7	16,9	0,60	9	0	58	95	20	36,34
8	53,9	0,25	12	0	49	50	95	41,51
9	73,0	2,30	40	0	98	90	95	17,96
10	68,1	0,30	49	0	53	210	190	26,37
11	68,1	1,18	26	0	54	120	85	24,37
12	67,9	0,74	43	0	91	125	55	33,77
13	69,0	0	43	13	53	60	120	9,22
14	71,1	0,20	27	0	60	40	340	7,12
15	52,2	0,46	23	0	37	75	75	19,95
16	31,1	0	13	7	35	42	80	8,96

Table 1: Soil variables in 10 upper cm (Lv = root length/cm^3)

When water can be found in the immediate vecinity of the roots, as is the case in these surface layers, (Hernández et al 1989) P uptake is favoured whatever the soil hydric regime or actual element concentration.

Although the communities located in sites 6,7 & 8 have 10 ppm of available P, they also show the highest root density in the first 10 cm of the soil (37.76 cm cm -3). However, because of their root morphology, grasses have an advantage over legumes in so far as P uptake is concerned (Hernández et al 1989).

	SITES 4	5	7	10	11	13
Trifolium subterraneum	1850	2510	1270	2340	1990	1710
Trifolium cernuum	2880	3100	1420	2100	-	-
Trifolium dubium	-	2200	1080	-	-	-
Trifolium repens	-	2720	-	-	2210	-
Ornithopus compressus	-	2090	-	1290	1340	1650
Agrostis castellana	1930	-	1160	1930	1630	1790
Gaudinia fragilis	-	2010	870	820	530	960
Bromus hordaceus	-	2720	1050	-	1080	1400
Holcus lanatus	-	2600	1920	-	1040	-
Holcus setiglumis	-	-	-	1580	1110	-
Dactylis glomerata	-	2120	-	-	1520	-
Cynosurus echinatus	-	2750	-	-	1720	-
Cynodon dactylon	1920	-	-	-	-	2240

Table 2: P composition (ppm) of legumes and grasses

The amount of assimilable P in acid soils is scarce. Nevertheless, there seems to be a tendency to a higher proportion of this fraction when there is no exchangeable Al. The P-Ca values are also lower than for the other two fractions. Since Ca has great mobility, the long-rooted perennial grasses (like Lolium perenne) can probably use these phosphates in the hydric conditions of these soils.

Fractioning by different authors has revealed that P adsorption in acid pasture soils preferently takes place as P-Al. This paper demonstrates the high positive correlation with assimilable P (r = 0.897 ***), a result that is analogous with those in other cambysol soils (Arines et al 1981). Rorison (1980) has related these high root phosphates concentrations with P absorption. There is also a large negative correlation with total root length in these surface layers (r = -0.753***). Nevertheless, when short roots are abundant in this soil section, the respective soils also present higher levels of inorganic phosphates. This suggests that at some moment in the dynamics of these compounds, part of the inorganic phosphates may enter the soil labile pool and be used by the plants whose roots are there.

Bibliography:

ARINES J et al Turrialba 31,217-226
HERNANDEZ A J et al 1988 12th General Meeting European Grassland Federation Dublin, 528-532
HERNANDEZ A J et al 1989 Henares Rev Geol 3,67-102
HERNANDEZ A J et al 1989 XVI Internat Grassland Conf Nice France, 15-16
PASTOR et al 1989 Henares Rev Geol 3,103-116
RORISON I H 1980 in "Effects of Acid Precipitation on Terrestrial Ecosystems" (Ed. Hutchinson and Hayes). Plienum Publi Corporat pp 283-303

ISBN 2-9505124-0-2

published by the

European Society of Agronomy,
B P 52,
68000 Colmar Cedex
FRANCE

Tel (33) 89 72 49 86
Fax (33) 89 72 49 33

Additional copies are available, price 25 ecu, from the above address

First Congress
of the

European Society of Agronomy

Paris 5th-7th December 1990

Proceedings

Edited by Alan Scaife

CEC ESA INRA